

Comparative Study of Properties of L-Arginine and Glycine in Maltose (aq) at 298, 308, 318K

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ABSTRACT

Glycine is the smallest of the 20 amino acids commonly found in proteins. Arginine is needed to keep the liver, skin, joints, and muscles healthy. The experimental data related to density, viscosity, sound speed for the system as L-Arginine and Glycine with Maltose(aq) are further utilized to derive parameters viz. apparent molal volume (Φ_v), limiting apparent molal volume (ϕ_v°) and experimental slope (S_v^*) by using Masson's equation. Intermolecular free length (L_f), specific acoustic impedance (Z), ultrasonic attenuation (α/f^2), Solvation number (S_n), free volume (V_f), viscous relaxation Time (τ) and internal pressure (Π_i). The concentration range preferred for L-Arginine and Glycine ranging from is 0.10m to 1.0m. The measurements are conducted at three temperatures viz. 298, 308, 318K so as to compare the results. The constancy of temperature is maintained by the use of refrigerated bath with water as circulating medium. The results are interpreted on the basis of solute-solvent and solute-solute interactions where the addition of solute and its concentration produces a major variation on the interactions. This shows the dependency of interactions on the concentration. This reveals the structure associative or dissociative nature of the solute-solvent.

Keywords: apparent molal volume, ultrasonic attenuation, solute-solvent interactions, structure association-dissociation

INTRODUCTION

Protein-carbohydrate interactions include the enzymatic synthesis and degradation of oligo- and polysaccharides, intracellular sorting of glycoconjugates, convey of carbohydrates into livelihood cells and of their derivatives into subcellular organelles, immunological retort to carbohydrate antigens and exodus of leukocytes to sites of inflammation. Amino acids as considered the fundamental component of proteins are suitable for understanding the interactions rousing between amino acid molecules and the entities present in the livelihood cell. Disaccharides can stabilize labile molecules in aqueous solutions by a combination of kinetic and specific effects [1]. Maltose is a disaccharide formed from two units of glucose.

Arginine helps strengthen the body's immune system, regulates hormones and blood sugar and promotes male fertility. In addition, it may progress circulation and treat impotency and heart disease. Glycine is a colorless, sweet-tasting crystalline solid, unique among the proteinogenic amino acids in that it is not chiral. It can fit into hydrophilic or hydrophobic environments, due to its single hydrogen atom side chain. The principal function of Glycine is as a precursor to proteins. It is found in germinating seeds such as Barley as they break down their starch stores to use for food. Also present in a small proportion in corn syrup, and forms on the partial hydrolysis of starch. It is a reducing sugar.

The study of amino acid with salt-water mixed solvent, urea-water solvent [2-4] has been carried out extensively, but thermo-acoustic study on amino acid-carbohydrate solutions is rare.

EXPERIMENTAL

0.01M aqueous solution of Maltose (minimum assay 99%, Himedia) was prepared. Solutions of Glycine and L-Arginine, in a concentration array of 0.1m to 1.0m (precision of $\pm 1 \times 10^{-4}$ g on electronic digital balance) with Maltose (aq) were prepared as weight to volume. Density by precalibrated bicapillary pycnometer (maximum error $\pm 0.06\%$), viscosity by precalibrated Ostwald's viscometer (maximum error $\pm 0.07\%$), sound speed by Ultrasonic interferometer (Mittal Enterprises, New Delhi, Model F-81) working at a fixed frequency of 2 MHz up to an accuracy of $\pm 0.04\%$ were measured at constant temperature in a refrigerated water bath maintaining temperature up to $\pm 0.1^\circ\text{C}$ [5-9]. The experimentation is carried out at three different temperatures viz. 298, 308, 318K so as to study the interactions more precisely.

RESULTS AND DISCUSSIONS

An insight into the nature of interactions can be carried out by calculating and discussing the parameters as:

Adiabatic Compressibility

$$\beta = 1/\rho u^2 \quad (\text{Eqn.1})$$

Apparent Molal Volume

$$\phi_v = \frac{1000(\rho_o - \rho)}{m\rho_o\rho} + \frac{M}{\rho} \quad (\text{Eqn.2})$$

Specific Acoustic Impedance

$$Z = u\rho \quad (\text{Eqn.3})$$

$$\text{Relative Association } R_A = (\rho/\rho_o)(u_o/u)^{1/3} \quad (\text{Eqn.4})$$

Intermolecular free length

$$L_f = K\beta^{1/2} \quad (\text{Eqn.5})$$

Solvation number

$$S_n = (n_1/n_2)(1 - \beta/\beta_0) \quad (\text{Eqn.6})$$

Internal Pressure

$$\pi_i = 44.2T^{4/3}u^{3/2}\rho \quad (\text{Eqn.7})$$

Ultrasonic Attenuation

$$\alpha/f^2 = 8\pi^2\eta/3u^3\rho \quad (\text{Eqn.8})$$

Free Volume

$$V_f = \left(\frac{M_{eff}u}{K\eta} \right)^{3/2} \quad (\text{Eqn.9})$$

Masson Equation

$$\phi_v = \phi_v^o + S_v^* \sqrt{m} \quad (\text{Eqn.10})$$

where ρ and ρ_0 are densities of solution and solvent, n_1 and n_2 are moles of solvent and solute, u_0 and u are sound speed of solvent and solution, β and β_0 are adiabatic compressibility of solution and solvent respectively, M is Molecular weight of solute (kg mole^{-1}), K is Jacobson's constant, m is molality of solution (moles kg^{-1}).

The values of density, viscosity for both the systems cover Table 1 and Table 2 respectively. The bulge in density and viscosity with the addition of solute is indicative of the hydrophobic temperament of the solute[10].

From the Φ_v data (Table 3) Φ_v vs. $m^{1/2}$ (Eqn.10) curves have been drawn and the plots were found to be non-linear in the concentration assortment deliberating positive slopes in Gly solution and negative slope for L-Arginine solution with Maltose(aq).

The intercept Φ_v^o which is the limiting apparent molal volume of the solute (equal to the partial molar volume at infinite dilution, \bar{v}_2^∞) is obtained by the least squares fitting of Φ_v values.

The type of interaction rousing between amino acid and Maltose(aq) molecules may be classified as follows:

- ❖ Hydrophilic-ionic group interactions between the $-\text{OH}$ group of the saccharides and the zwitterionic centre of the amino acid;
- ❖ Hydrophilic-hydrophobic group interactions between the $-\text{OH}$ group of the saccharides and the $-\text{NH}_2$ group of the amino acid mediated through the hydrogen bonding;
- ❖ Hydrophilic-hydrophobic group interactions between the $-\text{OH}$ group of the saccharides and the non-polar group of the amino acid;
- ❖ Hydrophobic-hydrophobic group interactions between the non-polar group of the saccharides and the non-polar group of the amino acid.

Even though carbohydrates are highly polar molecules, the steric disposition of the hydroxyl groups create hydrophobic patches on their surfaces, which can figure contacts with hydrophobic side chains of protein [11]. Cooperative bond is another kind of hydrogen bond attribute to protein-carbohydrate complexes, in which the hydroxyl group acts simultaneously as patron and acceptor. Most of the saccharides are uncharged, and therefore ionic, i.e. charge-charge, interactions do not commonly participates in the configuration of protein-carbohydrate complexes. Both the protein and ligand in aqueous solutions are normally bonded to water molecules by hydrogen bonding. Water acts as a molecule mortar, its small size and ability to serve as both hydrogen bond donor and acceptor endowing it with this purpose. Such bridges, which consist of single water molecule or chains of several water molecules, may be important for ligand recognition. During the process of complex formation, the protein-water and ligand-water hydrogen bonds are replaced by protein-ligand bonds and the unconfined water proceeds to bulk solvent[12,13]. When the complex finally forms, it presents a new surface to the adjoining medium, which is also hydrated.

Φ_v^o for both the system L-Arg+Matose(aq) decreases whereas te same increases for Gly+Maltos(aq) with the augmentation of temperature. The values of L-Arginine with Maltose are much superior to that for Glycine. Φ_v^o is a gauge of solute-solvent interactions, increases due to decline in the electrostriction at the terminals whereas it decreases due to upheaval of side group hydration by that of the charged end.

The increase in Φ_v^o from Glycine to L-Arginine may be due to amplified hydrophobicity/non-polar character of the side chain as the H atom of Glycine is replaced by a hydrophobic group ($-\text{CH}_3$) in L-Arginine. Relatively free N-terminal in Glycine would root the prime volume retrenchment followed by L-Arginine. The decrease in Φ_v^o with temperature may be aspect to adherence of solvent molecules in solution.

Small S_v^* values compared to Φ_v^o (Table 4) obtained (Eqn.10) clearly reveal that solute-solute interactions are weaker than solute-solvent interactions in both the systems, but inferior values for L-Arginine indicate lesser solute-solute interactions compared to Glycine. The negative values of A-coefficient decreases with temperature for L-Arg+maltose(aq), tends towards being escalating towards positive countenance of the graph thus demonstrating higher solute-solute interactions in Glycine. B-coefficient decreases with temperature in system of L-Arginine whereas the same increases with temperature for Glycine clearly demonstrating [14-16] L-Arginine as structure maker and Glycine as structure breaker.

Table1.Density of Systems: L-Arginine+Maltose(aq) and Glycine+Maltose(aq) at 298, 308 and 318K

Conc. (moles kg ⁻¹)	Density [ρ/(kg m ⁻³)]					
	L-Arginine + Maltose(aq)	Glycine + Maltose(aq)	L-Arginine + Maltose(aq)	Glycine + Maltose(aq)	L-Arginine + Maltose(aq)	Glycine + Maltose(aq)
	298K		308K		318K	
0.0000	990.2	990.2	988.1	988.1	986.0	986.0
0.1022	993.2	993.4	991.1	991.3	989.0	989.1
0.2045	998.6	997.6	996.6	995.5	994.5	993.3
0.3067	1004.5	1000.7	1002.4	998.2	1000.4	996.0
0.4089	1009.2	1003.9	1007.1	1001.4	1005.0	999.2
0.5112	1013.8	1006.3	1011.7	1004.0	1009.5	1001.2
0.6134	1018.3	1009.4	1016.2	1007.0	1014.0	1003.8
0.7157	1021.6	1011.4	1019.6	1009.3	1017.3	1007.1
0.8179	1025.0	1013.6	1023.0	1010.7	1020.7	1008.5
0.9201	1028.8	1016.6	1026.5	1014.3	1024.2	1011.5
1.0224	1032.5	1019.5	1030.1	1017.4	1027.6	1014.6

Table 2.Viscosity of systems: L-Arginine+Maltose(aq) and Glycine+Maltose(aq) at 298, 308 and 318K

Conc. (moles kg ⁻¹)	Viscosity(η/(x10 ⁻³ Ns m ⁻²))					
	L-Arginine + Maltose(aq)	Glycine + Maltose(aq)	L-Arginine + Maltose(aq)	Glycine + Maltose(aq)	L-Arginine + Maltose(aq)	Glycine + Maltose(aq)
	298K		308K		318K	
0.0000	0.9012	0.9012	0.7255	0.7255	0.6030	0.6030
0.1022	0.9437	0.9155	0.7579	0.7371	0.6293	0.6126
0.2045	0.9899	0.9259	0.7925	0.7456	0.6567	0.6200
0.3067	1.0277	0.9399	0.8220	0.7570	0.6779	0.6296
0.4089	1.1038	0.9516	0.8833	0.7664	0.7251	0.6370
0.5112	1.1752	0.9640	0.9378	0.7790	0.7684	0.6479
0.6134	1.2467	0.9782	0.9924	0.7876	0.8117	0.6547
0.7157	1.2854	0.9956	1.0159	0.8022	0.8417	0.6670
0.8179	1.4223	1.0067	1.1286	0.8124	0.9280	0.6790
0.9201	1.4842	1.0255	1.1761	0.8268	0.9613	0.6880
1.0224	1.5461	1.0386	1.2236	0.8386	0.9945	0.6975

Table 3. Apparent molal volume of systems: L-Arginine+Maltose(aq) and Glycine+Maltose(aq) at 298, 308 and 318K

Conc (moles kg ⁻¹)	Apparent molal volume [Φ _v (x 10 ⁻³ m ³ mol ⁻¹)]					
	L-Arginine + Maltose(aq)	Glycine + Maltose(aq)	L-Arginine + Maltose(aq)	Glycine + Maltose(aq)	L-Arginine + Maltose(aq)	Glycine + Maltose(aq)
	298K		308K		318K	
0.0000	----	----	----	----	----	----
0.1022	0.1461	0.0435	0.1461	0.0438	0.1461	0.0444
0.2045	0.1328	0.0387	0.1328	0.0387	0.1329	0.0389
0.3067	0.1266	0.0406	0.1266	0.0419	0.1266	0.0421
0.4089	0.1262	0.0410	0.1264	0.0422	0.1264	0.0424
0.5112	0.1260	0.0430	0.1261	0.0435	0.1264	0.0449
0.6134	0.1257	0.0431	0.1258	0.0437	0.1262	0.0454
0.7157	0.1272	0.0447	0.1272	0.0447	0.1276	0.0448
0.8179	0.1280	0.0456	0.1281	0.0466	0.1285	0.0467
0.9201	0.1282	0.0454	0.1286	0.0456	0.1290	0.0465
1.0224	0.1283	0.0453	0.1288	0.0453	0.1293	0.0460

Table4. Limiting Apparent molal volume at infinite dilution(Φ_v[°]), Constant S_v^{*}, Falkenhagen coefficient A and Jones-Dole coefficient B of systems L-Arginine+Maltose(aq) and Glycine+Maltose(aq) at 298, 308 and 318K

Φ _v [°] /(x10 ⁻³ m ³ mol ⁻¹)					
L-Arginine + Maltose(aq)	Glycine + Maltose(aq)	L-Arginine + Maltose(aq)	Glycine + Maltose(aq)	L-Arginine + Maltose(aq)	Glycine + Maltose(aq)
298K		308K		318K	
0.1356	0.0404	0.1355	0.0412	0.1354	0.0418
S _v [*] /(x10 ⁻³ m ³ l ^{1/2} mol ^{-3/2})					
L-Arginine + Maltose(aq)	Glycine + Maltose(aq)	L-Arginine + Maltose(aq)	Glycine + Maltose(aq)	L-Arginine + Maltose(aq)	Glycine + Maltose(aq)
298K		308K		318K	
-0.0108	0.0045	-0.0104	0.0040	-0.0098	0.0038
A/(dm ^{3/2} mol ^{-1/2})					
L-Arginine + Maltose(aq)	Glycine + Maltose(aq)	L-Arginine + Maltose(aq)	Glycine + Maltose(aq)	L-Arginine + Maltose(aq)	Glycine + Maltose(aq)
298K		308K		318K	
-0.1764	-0.0095	-0.1722	-0.0101	-0.1670	-0.0105
B/(dm ³ mol ⁻¹)					
L-Arginine + Maltose(aq)	Glycine + Maltose(aq)	L-Arginine + Maltose(aq)	Glycine + Maltose(aq)	L-Arginine + Maltose(aq)	Glycine + Maltose(aq)
298K		308K		318K	
0.8593	0.1576	0.8267	0.1609	0.7929	0.1633

Table5. Adiabatic Compressibility (β) of systems: L-Arginine+Maltose(aq) and Glycine+Maltose(aq) at 298, 308 and 318K

Conc (moles kg ⁻¹)	Adiabatic compressibility [β (x10 ⁻¹⁰ m ² N ⁻¹)]					
	L-Arginine + Maltose(aq)	Glycine + Maltose(aq)	L-Arginine + Maltose(aq)	Glycine + Maltose(aq)	L-Arginine + Maltose(aq)	Glycine + Maltose(aq)
	298K		308K		318K	
0.0000	4.5245	4.5245	4.4139	4.4139	4.3439	4.3439
0.1022	4.4230	4.4548	4.3284	4.3605	4.2635	4.2952
0.2045	4.3467	4.4068	4.2554	4.3115	4.1942	4.2515
0.3067	4.2638	4.3505	4.1834	4.2606	4.1267	4.2061
0.4089	4.1837	4.3010	4.1097	4.2129	4.0574	4.1604
0.5112	4.1059	4.2485	4.0358	4.1630	3.9883	4.1159
0.6134	4.0375	4.2113	3.9618	4.1187	3.9198	4.0798
0.7157	3.9641	4.1701	3.9041	4.0859	3.8639	4.0364
0.8179	3.8981	4.1268	3.8472	4.0499	3.8080	3.9940
0.9201	3.8305	4.0776	3.7866	4.0059	3.7480	3.9654
1.0224	3.7645	4.0316	3.7284	3.9614	3.7007	3.9244

Table6. Relative Association of systems L-Arginine+Maltose(aq) and Glycine+Maltose(aq) at 298, 308 and 318K

Conc (moles kg ⁻¹)	Relative Association(R_A)					
	L-Arginine + Maltose(aq)	Glycine + Maltose(aq)	L-Arginine + Maltose(aq)	Glycine + Maltose(aq)	L-Arginine + Maltose(aq)	Glycine + Maltose(aq)
	298K		308K		318K	
0.0000	----	----	----	----	----	----
0.1022	0.9997	1.0012	1.0002	1.0017	1.0004	1.0018
0.2045	1.0032	1.0040	1.0038	1.0048	1.0041	1.0051
0.3067	1.0068	1.0057	1.0079	1.0060	1.0084	1.0064
0.4089	1.0091	1.0076	1.0103	1.0078	1.0110	1.0083
0.5112	1.0113	1.0083	1.0127	1.0089	1.0133	1.0089
0.6134	1.0137	1.0104	1.0148	1.0105	1.0156	1.0105
0.7157	1.0145	1.0112	1.0162	1.0120	1.0171	1.0126
0.8179	1.0156	1.0119	1.0178	1.0121	1.0186	1.0125
0.9201	1.0170	1.0134	1.0190	1.0144	1.0200	1.0147
1.0224	1.0183	1.0149	1.0206	1.0161	1.0218	1.0165

Table7. Viscous Relaxation Time of systems L-Arginine+Maltose(aq) and Glycine+Maltose(aq) at 298, 308 and 318K

Conc (moles kg ⁻¹)	Viscous Relaxation Time [τ (x10 ⁻¹³ s)]					
	L-Arginine + Maltose(aq)	Glycine + Maltose(aq)	L-Arginine + Maltose(aq)	Glycine + Maltose(aq)	L-Arginine + Maltose(aq)	Glycine + Maltose(aq)
	298K		308K		318K	
0.0000	5.4368	5.4368	4.2698	4.2698	3.4923	3.4923
0.1022	5.5652	5.4377	4.3741	4.2854	3.5774	4.5083
0.2045	5.7370	5.4405	4.4968	4.2863	3.6722	3.5147
0.3067	5.8424	5.4520	4.5850	4.3004	3.7299	3.5309
0.4089	6.1573	5.4574	4.8399	4.3048	3.9229	3.5337
0.5112	6.4338	5.4607	5.0465	4.3239	4.0862	3.5556
0.6134	6.7111	5.4928	5.2422	4.3251	4.2422	3.5611
0.7157	6.7941	5.5357	5.2882	4.3703	4.3362	3.5897
0.8179	7.3925	5.5391	5.7891	4.3869	4.7120	3.6158
0.9201	7.5803	5.5754	5.9379	4.4161	4.8038	3.6376
1.0224	7.7604	5.5830	6.0830	4.4292	4.9071	3.6497

Table8. Internal Pressure of systems L-Arginine+Maltose(aq) and Glycine+Maltose(aq) at 298, 308 and 318K

Conc (moles kg ⁻¹)	Internal pressure [π (x10 ¹²) Nm ⁻²]					
	L-Arginine + Maltose(aq)	Glycine + Maltose(aq)	L-Arginine + Maltose(aq)	Glycine + Maltose(aq)	L-Arginine + Maltose(aq)	Glycine + Maltose(aq)
	298K		308K		318K	
0.0000	5.0307	5.0307	5.3527	5.3527	5.6500	5.6500
0.1022	5.1209	5.0938	5.4359	5.4062	5.7340	5.7025
0.2045	5.1953	5.1407	5.5133	5.4580	5.8131	5.7526
0.3067	5.2785	5.1946	5.5925	5.5105	5.8929	5.8029
0.4089	5.3604	5.2435	5.6742	5.5617	5.9751	5.8553
0.5112	5.4426	5.2952	5.7585	5.6153	6.0593	5.9058
0.6134	5.5177	5.3343	5.8455	5.6646	6.1454	5.9488
0.7157	5.5987	5.3765	5.9150	5.7021	6.2171	6.0016
0.8179	5.6744	5.4216	5.9855	5.7420	6.2905	6.0514
0.9201	5.7546	5.4747	6.0623	5.7943	6.3714	6.0885
1.0224	5.8353	5.5255	6.1386	5.8476	6.4378	6.1410

Table9. Free Volume of systems L-Arginine+Maltose(aq) and Glycine+Maltose(aq) at 298, 308 and 318K

Conc (moles kg ⁻¹)	Free Volume[V _∞ 10 ⁻³ m ³]					
	L-Arginine + Maltose(aq)	Glycine + Maltose(aq)	L-Arginine + Maltose(aq)	Glycine + Maltose(aq)	L-Arginine + Maltose(aq)	Glycine + Maltose(aq)
	298K		308K		318K	
0.0000	15.2653	15.2653	21.5646	21.5646	28.8530	28.8530
0.1022	5.2494	1.5456	7.4241	2.1774	9.9405	2.9114
0.2045	4.9300	1.5271	7.0031	2.1516	9.4018	2.8721
0.3067	4.7078	1.5041	6.6858	2.1177	9.0336	2.8238
0.4089	4.2749	1.4855	6.0620	2.0917	8.2409	2.7908
0.5112	3.9330	1.4679	5.5974	2.0553	7.6271	2.7387
0.6134	3.6334	1.4422	5.1965	2.0336	7.0936	2.7088
0.7157	3.5097	1.4129	5.0603	1.9867	6.7737	2.6487
0.8179	3.0459	1.3983	4.3586	1.9603	5.9002	2.5967
0.9201	2.8873	1.3692	4.1357	1.9199	5.6493	2.5540
1.0224	2.7438	1.3519	3.9320	1.8912	5.4065	2.5158

Table10. Ultrasonic attenuation of systems L-Arginine+Maltose(aq) and Glycine+Maltose(aq) at 298, 308 and 318K

Conc (moles kg ⁻¹)	Ultrasonic attenuation(α/β)x10 ⁻¹⁵ s ⁻² m ⁻¹					
	L-Arginine + Maltose(aq)	Glycine + Maltose(aq)	L-Arginine + Maltose(aq)	Glycine + Maltose(aq)	L-Arginine + Maltose(aq)	Glycine + Maltose(aq)
	298K		308K		318K	
0.0000	7.1891	7.1891	5.5707	5.5707	4.5151	4.5151
0.1022	7.2867	7.1462	5.6596	5.5660	4.5890	4.5175
0.2045	7.4671	7.1262	5.7850	5.5475	4.6852	4.5122
0.3067	7.5535	7.1064	5.8657	5.5403	4.7342	4.5147
0.4089	7.9037	7.0845	6.1511	5.5236	4.9487	4.5008
0.5112	8.2000	7.0536	6.3702	5.5223	5.1220	4.5089
0.6134	8.5008	7.0747	6.5711	5.5025	5.2833	4.5022
0.7157	8.5413	7.1021	6.5911	5.5443	5.3706	4.5215
0.8179	9.2313	7.0771	7.1747	5.5447	5.8034	4.5336
0.9201	9.4004	7.0914	7.3132	5.5610	5.8798	4.5511
1.0224	9.5579	7.0709	7.4473	5.5547	5.9781	4.5494

Table11. Acoustic Impedance of systems: L-Arginine+Maltose(aq) and Glycine+Maltose(aq) at 298, 308 and 318K

Conc (moles kg ⁻¹)	Acoustic Impedance[Zx10 ⁶ kg m ⁻² s ⁻¹]					
	L-Arginine + Maltose(aq)	Glycine + Maltose(aq)	L-Arginine + Maltose(aq)	Glycine + Maltose(aq)	L-Arginine + Maltose(aq)	Glycine + Maltose(aq)
	298K		308K		318K	
0.0000	1.4794	1.4794	1.4962	1.4962	1.5066	1.5066
0.1022	1.4985	1.4933	1.5132	1.5078	1.523	1.5175
0.2045	1.5157	1.5046	1.5303	1.5195	1.5398	1.5285
0.3067	1.5349	1.5166	1.548	1.5306	1.557	1.5388
0.4089	1.5531	1.5278	1.5654	1.5417	1.5738	1.5497
0.5112	1.5713	1.5390	1.5833	1.5530	1.5909	1.5597
0.6134	1.5881	1.5482	1.6016	1.5636	1.6083	1.5686
0.7157	1.6053	1.5574	1.616	1.5717	1.6226	1.5796
0.8179	1.6216	1.5672	1.6307	1.5798	1.6372	1.5891
0.9201	1.6387	1.5790	1.6464	1.5912	1.6531	1.5971
1.0224	1.6561	1.5902	1.6622	1.6026	1.6664	1.6079

Table 5 discloses the values of adiabatic compressibility. For both the systems values decreases with the enhancement of concentration, but the values of system I: L-Arginine with maltose (aq) are very much low compared to system II: Glycine with Maltose (aq). β depends on the increasing compression of solvent (maltose boded water molecules) around the solute. When a solute is added to solvent [17], a novel constitution of solvent and solute molecules causes dwindle in compressibility of solution thereby reducing free solvent molecules for the upcoming solute.

The values of Relative association (Table 6) are assessment of the temperament of the solute-solvent and solvent-solvent interactions. R_A is influenced by two factors (i) The breach of solvent structure on addition of solute to it; and (ii) the solvation of solutes that are simultaneously present. The decrease in R_A is due to the former and latter results in increase of R_A . The increase of R_A with concentration suggests that

solvation of solutes predominates over the breaking up of solvent structure for both the systems. Increase in R_A with temperature also indicates that thermal confrontation increases the solute-solvent interaction causing breaking of the solvent-solvent molecular coalition [18]. The values reveal that association in system 1 of L-Arginine+Maltose (aq) is greater than system 2 of Glycine +Maltose (aq).

Viscous relaxation time increases with the addition of solute in both the systems whereas the same decreases with the elevation of temperature (Table 7). The results may be attributed to the resistance offered by viscous force in the stream of sound waves as a classical absorption [19]. The observations evidently indicate that the values of τ for system of L-Arginine with Maltose (aq) are higher proving the higher viscosity of L-Arginine with Maltose (aq) compared to Glycine in Maltose (aq). Thermal increase decreases the viscosity and hence produces an effect on viscous relaxation coefficient.

Internal pressure plays an imperative chore in elucidating molecular interactions, as this represents the ensuing of forces of attraction and repulsion flanked by the molecules [20]. The internal pressure values increases with concentration and the raise is much higher in L-Arginine system rather than Glycine system (Table 8). The values noticeably disclose the formation of a tense solvation layer around the solute zwitterions. Thermal rise causes an increase in the solvation layer as also evident by the decrease in compressibility values.

Free volume is in coordination with the decreasing internal pressure values [21]. The V_f decreases with the increase in concentration of solute (Table 9) whereas the same increases with the temperature thus attributing to the fact that hydration shell of Glycine is predominantly controlled by electrostatic interaction of solvent molecules due to absence of any aliphatic side chain. The higher values of V_f apportion that solute-solvent interaction is less in the system with high values of V_f .

Ultrasonic attenuation values for L-Arginine are once again superior to that for Glycine in Maltose (aq). For both the systems (Table 10) the values increases with the concentration for L-Arg and decreases with the increase of temperature. The values for Gly decreases with concentration and temperature. The increase in values is attributed to the structure formation around solvent molecules due to addition of solute. Earlier findings [22] disclose that the motion of molecules in mixture solvents is less than that in untainted components. The increased frictional force/impediment in the motion of solute cause increase in the ultrasonic absorption or attenuation.

The augmented values of acoustic impedance (Table 11) with concentration increase can be explained on the basis of lyophobic interaction between solute and solvent molecules which increases the intermolecular distance [23] and thus becomes accountable for the promulgation of ultrasonic waves.

CONCLUSION

The decrease in apparent molal volume with concentration in Glycine system can be explained on the foundation of linear configuration and relatively small size of molecule causative to volume retrenchment of the mixture. The presence of ($--CH_3$) group on L-Arginine is responsible for the structural behavior of amino acid. B-coefficient decreases with temperature in system of L-Arginine whereas the same increases with temperature for Glycine clearly signifying L-Arginine as structure maker and Glycine as structure breaker. The higher values of most of the parameters in L-Arginine system as discussed above are due to commotion of the hydration globe of the

charged end centre, leading to dominating ionic-hydrophilic interactions.

Thus with the presence of side chain in amino acid the structure forming aptitude with the solvent increases as evidently represented by the number of parameters taken into contemplation.

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APPENDIX 1

Symbols:

- | | |
|---------------|---------------------------------------|
| 1. ρ | density of solution |
| 2. ρ_o | density of solvent |
| 3. β | Adiabatic compressibility of solution |
| 4. β_o | Adiabatic compressibility of solvent |
| 5. u | sound speed of solution |
| 6. u_o | sound speed of solvent |
| 7. T | temperature in K |
| 8. η | viscosity of solution |
| 9. η_o | viscosity of solvent |
| 10. m | molality of solution |
| 11. M_{eff} | effective molecular weight |
| 12. K | Jacobson's constant |
| 13. n_1 | moles of solvent |
| 14. n_2 | moles of solute |
| 15. α | ultrasonic absorption |
| 16. f | frequency |
| 17. π_i | internal pressure |